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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In the Matter of	)	
	)	
Amendment of Section 2.106 of the	)	ET Docket No. 95-18
Commission's Rules to Allocate	)	RM-7927
Spectrum at 2 GHz for Use	)	PP-28
by the Mobile-Satellite Service	)	

REPLY OF THE MSS COALITION

Celsat America, Inc. ("Celsat"), COMSAT Corporation ("COMSAT"), Hughes Space and Communications International ("Hughes"), ICO Global Communications ("ICO"), and Personal Communications Satellite Corporation ("PCSAT")[1] (collectively, the "MSS Coalition" or "Coalition"), by their attorneys submit this reply to the oppositions to the MSS Coalition's petition for partial reconsideration ("Petition") of the Federal Communications Commission's ("FCC" or "Commission") March 14, 1997 Order ("Order" or "2 GHz Order")[2] in the above-referenced proceeding.

INTRODUCTION

The MSS Coalition sought reconsideration because portions of the Commission's Order effectively will erect a significant barrier to entry for prospective Mobile Satellite Service ("MSS") operators in the 2 GHz band, depriving U.S. consumers of the full benefits of MSS. As the supportive comments of Iridium LLC and L/Q Licensee, Inc. illustrate, the consensus view within the satellite industry is that the MSS Coalition's Petition is meritorious and should be granted.

In reviewing the Petition, the MSS Coalition urges the Commission to focus on the implications of the 2 GHz Order on successful global development of MSS at 2 GHz. Specifically, recognizing the

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[1] PCSAT is a wholly owned subsidiary of American Mobile Satellite Corporation.

[2] *Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz for Use by the Mobile-Satellite Service,* ET Docket 95-18, FCC No. 97-93 (Mar. 14, 1997)("Order" or "Further Notice").

growing substantial demand for spectrum by MSS providers, the United States led the charge at the 1992 World Administrative Radio Conference ("WARC-92") to persuade the international participants that spectrum at 2 GHz be allocated to MSS. At the time WARC-92 allocated this spectrum, however, neither the countries involved nor potential MSS operators contemplated that the United States would impose substantial relocation expenses on MSS operations in the U.S. and thereby erect a significant barrier to entry into the U.S. market. For the Commission now effectively to preclude MSS operators from utilizing that spectrum in the United States compromises the leadership role it has consistently assumed in encouraging the development of all satellite services, and specifically MSS.

I. THE BROADCAST INTERESTS' ATTACK UPON THE STATE OF DIGITAL TECHNOLOGY IS BASELESS

The Society of Broadcast Engineers, Inc. ("SBE"), ABC, Inc., the Association for Maximum Service Television, Inc., the National Association of Broadcasters, the Radio-Television News Directors Association and A.H. Belo (collectively, the "Broadcast Interests") criticize the MSS Coalition's evaluation of the state of digital technology that can be used for Broadcast Auxiliary Service ("BAS") electronic news gathering ("ENG") operations. As the MSS Coalition highlights below and discusses more fully in the supplemental Engineering Statement prepared jointly by COMSAT and Hughes (attached to this reply as Exhibit A), the Broadcast Interests' criticisms are unfounded. In light of the recent Digital Television ("DTV") orders, it is not a question of whether broadcasters will "go digital," but rather when they will do so. The Commission must not accede to the Broadcast Interests' refusal to acknowledge the advanced state of digital technology for ENG applications in order to protect their ability to operate in a soon-to-be outdated and spectrally inefficient FM analog mode.

We briefly address below each of the Broadcast Interests' concerns.

Video Quality and Required Bit Rates for DTV. The Broadcast Interests claim that the MSS Coalition underestimated the bit rates and associated RF bandwidth needed for high-quality digital ENG by

basing its estimates on relatively low-motion video ("talking heads") rather than the high-motion pictures associated with sports and entertainment events.[3] Contrary to the Broadcast Interests' assertions, the MSS Coalition adequately demonstrated the feasibility of digital ENG transmissions for all applications ranging from low-motion video to high-motion video.[4] As the MSS Coalition discussed, and as the Broadcast Interests are well aware, the overwhelming majority of electronic news gathering material can be sufficiently encoded with MPEG-2 4:2:0 codecs while maintaining "contribution" quality video. In the selected cases where these (MPEG-2 4:2:0) codecs may not suit all the users' video quality needs, other types of codecs are readily available, such as the Panasonic DVCPRO and Sony SX, that are gaining industry acceptance as SBE and ABC have conceded. The use of these codecs combined with higher order modulation will allow transmission of the higher encoded bit rates within the 12 MHz channels proposed by the MSS Coalition in one of its channelization options.

Implications for HDTV. The Broadcast Interests claim that future DTV with higher definition formats, such as HDTV, will require higher bit rates and consequently more spectrum.[5] Although the HDTV formats may require higher bit rates, it is still technically feasible to transmit any of these HDTV

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[3] Opposition to Petition for Partial Reconsideration of the Society of Broadcast Engineers, Inc. at 3-6 (June 17, 1997) ("Opposition of SBE"); Opposition to Petition for Partial Reconsideration of the MSS Coalition of ABC, Inc. at 7-9 (June 19, 1997) ("Opposition of ABC"). The MSS Coalition notes that ABC's criticism, Opposition of ABC at 8-9, that the COMSAT/Wegener equipment failed to provide adequate quality is groundless. The ABC study was based on a two year old pre-production prototype codec. The production version of the codec is currently used by two major networks both for backhaul and distribution of fast-action sports and news programming. Engineering Statement at 2.

[4] Engineering Statement at 1-2. *See also* Petition for Partial Reconsideration of the MSS Coalition, Exhibit A at 7-8 (May 20, 1997).

[5] Opposition of ABC at 9-11; Opposition to Petition for Reconsideration of Assoc. for Maximum Serv. Television et al. at 5 (June 19, 1997) ("Opposition of MSTV").

formats in the 12 MHz channels that the MSS Coalition proposed as one channelization option for 2 GHz ENG.[6]

Degradation Caused by Multiple Generation Compression for Editing. The Broadcast Interests claim that the Coalition ignores the issue of multiple generation compression, *i.e.*, the compression and decompression of an ENG signal as it moves from field-to-network, network-to-station, and station-to-viewer.[7] Multiple generation compression may be necessary to permit editing, but it does not have to pose a video quality problem. Moreover, while final video quality resulting from multiple generation compression is dependent on how much the signal is compressed at each step, if appropriate measures are taken at each step, little, if any, visual degradation will be introduced to the video.[8]

Latency. The Broadcast Interests claim a so-called latency problem, *i.e.*, the time delay associated with digital compression.[9] Newer versions of production codecs now provide substantially less -- about one quarter -- of the delay time associated with digital compression than codecs produced just one or two years ago. Some of the latest codecs, such as Tiernan's MPEG-2 codec, have demonstrated delays of approximately 130 milliseconds ("ms"). Likewise, Leitch soon will be offering its new codec that can obtain propagation delays of approximately 100 ms. These delay figures are substantially less than the 250 ms propagation delay experienced on SNG links for comparable "live" real-time applications.[10]

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[6] Engineering Statement at 2-3. Moreover, in the relatively few instances where spectrum demand far exceeds supply -- *e.g.*, the Oklahoma City bombing -- there is no reason to believe that BAS operators will not be able to continue their current practice of obtaining special temporary authorizations to use neighboring spectrum for coverage of "breaking" news events of national importance.

[7] Opposition of SBE at 3-6.

[8] Engineering Statement at 3.

[9] Opposition of SBE at 6-7; Opposition of ABC at 13.

[10] Engineering Statement at 4.

Robustness of DTV Signals in Comparison to FM-TV. The Broadcast Interests also dispute the MSS Coalition's statements about the robustness of digital signals as compared to analog-FM signals. Although the Broadcast Interests concede that digital signals could have superior performance for so called "engineered" paths using forward error correction ("FEC"), they claim that FEC is not practical for "non-engineered" paths.[11] Regardless of whether a path is "engineered" or "non-engineered," the MSS Coalition defends the inherent robustness of digital transmission using appropriate digital modulation schemes, such as QPSK.[12]

Frequency Coordination of the MSS Coalition's Proposed Channel Plans. The Broadcast Interests claim that the MSS Coalition's proposed flexible channelization plans would hinder frequency coordination among ENG users because the flexible channel bandwidths would no longer be interchangeable.[13] This criticism reflects a fundamental misunderstanding of the MSS Coalition's proposal that advanced two separate channelization plans.[14] If either plan creating sub-divided channels were implemented, it would allow broadcasters to combine adjacent channels for sufficient bandwidth to broadcast in analog mode if so desired.[15] This approach is no more complex than the technical approaches used fairly routinely today by broadcasters in order to obtain frequency re-use of a given ENG channel. In fact, the channelization plans proposed by the MSS Coalition would give the ENG operators *greater* flexibility than the static-bandwidth ENG channels in use today.[16]

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[11] Opposition of SBE at 6.

[12] Engineering Statement at 4-5.

[13] Opposition of SBE at 7-8; Opposition of A.H. Belo Corp. at 2-3.

[14] *See* Petition at 19, n.50, Exhibit A at 12-13.

[15] Of course, the local ENG frequency coordinator would have to be notified as to which mode (digital TV or analog FM) a given station was intending to transmit in, and the size channel (regular or double) that transmission would occupy.

[16] Engineering Statement at 5-6.

Equipment Requirements for Portable ENG Applications. The Broadcast Interests claim that the MSS Coalition ignored the current unavailability of digital equipment for the small size, moving (portable) radio frequency ("RF") cameras used regularly in production by ABC and others.[17] Although portable RF cameras are used in BAS operations, they comprise a very small percentage of the total population of all ENG transmitters/receivers and, therefore, should not form the sole basis upon which the Commission bases such a signification spectrum allocation decision. Moreover, portable RF cameras operating in analog mode can be accommodated in the MSS Coalition's flexible channelization plans.[18]

As the foregoing demonstrates, the Broadcast Interests' technical comments lack merit and should not prevent the Commission from granting the Petition.

II. THE BROADCAST INTERESTS FAIL TO DEMONSTRATE THAT THE COMMISSION'S DECISION TO ALLOCATE 20 MHz OF SUPPLEMENTAL SPECTRUM TO BAS WAS BASED ON A COMPLETE RECORD

Rather than identify specific new information in the record that supports the Commission's decision to allocate 20 MHz of supplemental spectrum to BAS, the Broadcast Interests merely highlight existing information that the MSS Coalition has demonstrated was insufficient to support a Commission decision in favor of a BAS allocation at 2110-2130 MHz. The Broadcast Interests have not pointed to *anything* in the record that supports the Commission's decision to award BAS supplemental spectrum, because they cannot do so. The Commission implicitly acknowledges that it lacks information regarding the actual spectrum needs of BAS operations by the questions asked in its Further Notice of Proposed Rulemaking.[19] Absent such critical information about BAS spectrum needs, the Commission's decision cannot stand.

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[17] Opposition of ABC at 11-13; *see also* Opposition of SBE at 6; Opposition of A.H. Belo Corp. at 2.

[18] Engineering Statement at 6-7.

[19] The Commission seeks comment on: (1) whether all seven BAS channels are needed in all markets; (2) whether BAS licensees would be able to operate with narrower channels by switching to digital equipment; and (3) what implications the broadcast industry's conversion from analog to digital may have for BAS spectrum requirements. Further Notice at ¶ 68.

Because they have failed to demonstrate that such information was presented to the Commission in advance of the Order, the Broadcast Interests have provided no sound reason upon which to deny the instant Petition.

As the MSS Coalition noted in its Petition, the Commission accorded BAS 20 MHz of supplemental spectrum based on the Broadcast Interests' assertion that BAS demand currently exceeds supply. The Broadcast Interests' sole support for its assertion was (and remains) an industry survey of 2 GHz spectrum coordinators in the top 25 broadcast markets. The Broadcast Interests now claim that "because BAS is a nationwide service, the variability of needs market by market has little effect on the block allocation that BAS uses."[20] The Broadcast Interests' explanation directly contradicts what is apparently the Commission's own understanding of BAS, however. Specifically, the Commission states that "it is possible that in some markets not all of the seven BAS channels will be needed."[21] Moreover, the Commission also implies that in some markets, only five channels are necessary to accommodate BAS requirements.[22] Clearly, the Commission contemplates assessing BAS spectrum needs on a market-by-market basis. Absent a market-by-market analysis of such needs, the Commission's decision to provide BAS with supplemental spectrum was unwarranted, arbitrary and capricious and an abuse of discretion. The Broadcast Interests have failed to prove otherwise.

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[20] Opposition of MSTV at 8.

[21] Further Notice at ¶ 68. In addition, the Coalition notes that more than 250 MHz in other frequency bands also is allocated to BAS.

[22] *See id.* (in some markets, BAS licensees "may prefer to adhere to the current BAS channel plan, simply foregoing the use of channels A1 and A2 . . . .")

III. THE MSS COALITION'S PROPOSAL BEST BALANCES THE COMPETING INTERESTS OF THE MSS OPERATORS AND INCUMBENT FS LICENSEES

A number of parties that oppose the MSS Coalition's Petition contend that the Commission's decision to impose relocation costs on MSS operators is the "fair" result.[23] The MSS Coalition submits that the "fair" result is not one in which one party's interest prevails at the other's expense, but, rather, one in which all parties' interests are balanced equitably. The MSS Coalition's proposal regarding the transition of incumbent FS operators best strikes that balance.

The MSS Coalition's transition proposal is straightforward. MSS operators and FS licensees will, in the vast majority of instances, be able to share the 2165-2200 MHz downlink band for a transition period of several years.[24] After several years, however, growing traffic on MSS systems will increase the chance that there will be harmful interference between FS and MSS operations, thus requiring FS licensees to vacate the band.[25] As the MSS Coalition explained in its Further Comments filed in this proceeding on June 23, 1997, by the time actual interference between FS and MSS operators occurs, most of the equipment used by the majority of FS licensees should be fully amortized or in need of replacement by

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[23] *See* Opposition of the Affiliated American Railroads to Petition for Partial Reconsideration of the MSS Coalition at 3. *See also* Opposition of APCO to MSS Coalition Petition for Partial Reconsideration at 4 ("Opposition of APCO").

[24] The MSS Coalition is heartened by statements made by certain FS licensees in their oppositions that these licensees remain committed to ongoing spectrum sharing efforts. *See, e.g.*, Opposition of APCO at 5.

[25] The statement made by two FS licensees that incumbents will need to be relocated prior to the time they experience actual interference from MSS operations, *see* Opposition to Petition for Partial Reconsideration of ALLTEL Communications, Inc. at 3 (June 19, 1997); Opposition of the American Petroleum Institute at 6 (June 19, 1997), is wrong. The Commission states that relocation need not occur "unless and until the incumbents will receive harmful interference from, or cause harmful interference to, a new technology service." Order at ¶ 42. The harmful interference standard is an operational, not a hypothetical, one. *See* 47 C.F.R. § 2.1. As such, relocation need not occur until there is actual harmful interference between an incumbent licensee and an operational MSS system.

Celsat notes, as it has in previous rulemaking proceedings before the Commission, that it can operate in the 1990-2025 MHz and 2165-2200 MHz bands without causing harmful interference either to BAS-ENG facilities or FS facilities.

more efficient digital equipment.[26] Thus, by requiring incumbent FS licensees to pay for the costs of relocating out of the 2165-2200 MHz downlink band by the reasonable sunset date of January 1, 2005,[27] the Commission would not be imposing on those FS licensees any costs beyond those that they would incur in the normal course of business. Accordingly, the Commission should reject the relocation proposal set forth in the Order in favor of the MSS Coalition's transition proposal.

The MSS Coalition's transition proposal also is consistent with Commission precedent. Contrary to the claims of a number of parties filing oppositions,[28] the relocation rules established in the emerging technologies proceeding do not automatically apply to MSS. The Commission specifically stated in its first order addressing microwave relocation that, "as new services develop, we may review our relocation rules and make modifications to these rules where appropriate."[29] Thus, the Commission never intended that the relocation rules adopted in the emerging technologies proceeding necessarily would be applied in wholesale fashion to all emerging technology services.[30] For the reasons set forth in the MSS Coalition's Petition, the public interest would not be served by the application of those relocation rules to MSS

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[26] Further Comments of the MSS Coalition at 8 (June 23, 1997).

[27] The MSS Coalition has urged the Commission to adopt this sunset date. *See* Further Comments of the MSS Coalition at 6-9.

[28] *See, e.g.*, Opposition of UTC to MSS Coalition's Petition for Partial Reconsideration at 3 (June 19, 1997).

[29] *Amendment to the Commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation*, 11 FCC Rcd 8825, 8870 (1996) ("*Microware Relocation*").

[30] As the MSS Coalition pointed out in an earlier pleading, such an approach is consistent with the Commission's historical support of sharing solutions as a means of expediting the introduction of new services. *See* Petition of the MSS Coalition for Clarification or, in the Alternative, Partial Reconsideration, *Microware Relocation*, at 3-5 (July 12, 1996). Indeed, even as it adopted relocation rules in the emerging technologies proceeding, the Commission stated that it was allocating spectrum "for the development and implementation of emerging technologies on a *shared basis* with the fixed service." *Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, 7 FCC Rcd 6886, 6890 (1992) (emphasis added).

operators. As the MSS Coalition urged in its Further Comments, the Commission instead should require only a sunset provision and the use of proven spectrum sharing and frequency coordination processes.[31]

CONCLUSION

For all of these reasons, the Commission should grant expeditiously the MSS Coalition's Petition.

Respectfully submitted,

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[31] Further Comments of the MSS Coalition at 3-10.

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EXHIBIT

A

Exhibit A

ENGINEERING STATEMENT

1. Video Quality

The broadcasters assert that the MSS Coalition has underestimated the bit rate and bandwidth required for digital ENG by "using bit rates and occupied bandwidth only fit for low-motion pictures", and that the Coalition has confused contribution quality with distribution quality. (See ABC at 6-9; SBE at 3-4). ABC is particularly critical of the COMSAT/Wegener codec in achieving "contribution quality" in tests performed over two years ago at ABC Labs. We address each of these issues below.

A. Bit Rate and Contribution Quality

The broadcasters' concern for maintaining contribution quality video can be fully accommodated by the MSS Coalition's proposals. A very high percentage of electronic news gathering material is comprised of pictures with little motion, specifically the "talking head" type of news interviews and stand-ups. SBE concedes that pictures with little motion can be heavily compressed. (SBE at 3-4). For such low motion, low bit-rate programming, MPEG-2 4:2:0 codecs provide the contribution quality video that broadcasters demand for their news gathering applications. The MSS Coalition agrees with SBE that pictures with large amounts of motion require higher bit rates and consequently need more bandwidth for transmission. (SBE at 3-4). Certain sporting events, such as basketball, obviously require a higher encoded bit rate than "talking heads". Nevertheless, even most sporting events can be transmitted with very high video quality using MPEG-2 4:2:0 codecs at the higher encoded bit rate range of 8 to 12 Mbps and these rates will still fit comfortably within the proposed 12 MHz channel bandwidth using QPSK modulation. ABC (at 4) claims that the MSS Coalition's assessments are "wildly optimistic and based on best-case scenarios rather than real-world situations." However, two major networks are transmitting digitally encoded video over satellite (using MPEG-2 4:2:0 codecs) for backhaul and distribution of fast-action sports and news programming. The MPEG-2 4:2:0 codecs have the capability of varying the encoded bit rate typically up to 15 Mbps. In most news gathering applications, however, it is not necessary to use 15 Mbps. Lower bit rates such as 6 to 8.5 Mbps provide more than adequate video quality for news applications as demonstrated by broadcast networks' usage of these codecs for satellite news gathering ("SNG").

The MSS Coalition recognizes that, in certain cases, MPEG-2 4:2:0 codecs may not provide the sufficient chroma range necessary for selected source material. In these cases, alternative codecs such as Panasonic DVCPRO and Sony SX MPEG-2 4:2:2 are indeed available and are gaining broadcast industry acceptance, as SBE and ABC acknowledge. (See SBE at 5; MSTV Joint Comments, May 17, 1996, ABC Engineering Statement of Michael J. Stein, Capital Cities/ABC, section on "Contribution Quality" at 2). ABC indicates that these two formats meet their contribution video quality demands. Their argument, therefore, is not that the video quality does not meet their contribution quality standards, but rather that the bit rate is too high to be transmitted within the smaller channel bandwidths proposed by the MSS Coalition. Although it is

true that the output bit rates from the Sony SX and Panasonic DVCPRO are higher than standard MPEG-2 4:2:0 codecs, the output bit rates from even these codecs can still fit within 12 MHz bandwidth. As stated in the White Paper, the encoded video bitstream from a Sony SX (output bit rate of 21 Mbps) modulated with either 16-QAM or 8-PSK digital modulation can easily be accommodated within the 12 MHz bandwidth proposed by the MSS Coalition as one of the possible rechannelization plans. (MSS Coalition Petition, Exhibit A at 8.)

B. ABC Test of COMSAT/Wegener Codec

During the summer of 1995, ABC Engineering Laboratory received and tested a prototype of the COMSAT/Wegener VideoLinx 2000 compression system. ABC's conclusion from the test of this equipment was that it would not meet their definition of contribution quality. However, ABC's test of the COMSAT/Wegener codec did not fairly or adequately reflect the performance of this equipment for ENG transmission. (See ABC at 8-9, citing MSTV Joint Comments, May 17, 1996, ABC Engineering Lab Report.) Two major flaws exist in the test methodology employed by ABC. First, ABC compared the quality of original material with the compressed / decompressed material. A proper analysis would involve a side-by-side comparison of the quality of analog FM video with digital compressed / decompressed video. Second, in evaluating the COMSAT/Wegener codec, ABC did not use rigorous formal viewing tests, as provided for in Recommendation ITU-R BT.500-6 ("Methodology for the Subjective Assessment of the Quality of Television Pictures"). Because ABC did not use any systematic analysis of performance, its claims regarding the failure of the COMSAT/Wegener codec are not credible.

It should also be noted that the ABC test of the COMSAT/Wegener equipment involved a two-year old pre-production prototype long since replaced by higher quality production equipment. Many SNG customers are currently using this higher quality equipment to support a wide variety of backhaul and distribution applications, including the backhaul and distribution of sports and news programming. To date, no complaints have been received from production engineers concerning the video quality performance of this equipment or similar codecs produced by other manufacturers. These MPEG-2 4:2:0 codecs have been accepted throughout the broadcast industry for SNG applications, which has many operational similarities to ENG. Moreover, second generation SNG equipment is now commercially available, and it is likely that third generation SNG equipment will be available in the time frame in which ENG trucks would need to be converted to digital. With each year we can expect to see significant improvements in cost, performance, size, and weight for digital compression equipment suitable for digital ENG applications.

2. Future DTV

The broadcasters state that future digital television with higher definition formats (such as 720P, 1080I and 1080P) will require more data. (ABC Comments at 10; NAB Comments at 5.)

While future high definition digital television (HDTV) will certainly require higher bit rates than standard DTV, these higher resolution digital TV formats can be accommodated within a channel plan of 12 MHz per channel such as the MSS Coalition recommends for 2 GHz ENG. It is

certainly technically feasible to transmit high definition formats such as 720P, 1080I, and 1080P using MPEG-2 compression with high order modulation schemes within 12 MHz. The MSS Coalition acknowledges that the bandwidth efficiency of QPSK needs to be upgraded for a more bandwidth efficient transmission or modulation scheme to be used with HDTV. The specific modulation technique will depend on the specific HDTV video format implemented by the broadcast industry. At present, the broadcast industry has not decided which, or how many, of the video formats will be selected to be the future HDTV standard. Until there is an agreed HDTV format, there will be little progress on any commercially available HDTV equipment being manufactured, including compression codecs for any television production operations, including ENG. Therefore, it is misleading for the broadcasters to state that the higher bit rates demanded for HDTV cannot be accommodated within 12 MHz. Even if the broadcasters were to select the highest resolution format, such a format could still be accommodated in a 12 MHz flexible channel plan. (See MSS Coalition Petition, Exhibit A at 7-8.)

3. Multiple Generation Compression/Editing

The broadcasters maintain that multiple generation compression is required to permit editing. SBE, in particular, expresses concern that "if the picture is initially highly compressed at the RF camera, then must suffer up to three more compression / decompression cycles...the artifacts created by the multiple lossy compression cycles can become ugly, depending upon how hard the signal was compressed at each step." (SBE at 4-5; ABC at 9-10).

Multiple generation compression may be necessary to permit editing, but it does not have to pose a video quality problem. The final video quality resulting from multiple generation compression is indeed dependent on how much the signal is compressed at each step. Obviously the amount of compression must be tailored to the programming material and the stage in the production cycle that the video signal is in. The MSS Coalition has never suggested that the video from field cameras should be heavily compressed so that egregious artifacts would be introduced into the beginning, or any other stage, of the video production. There are numerous options available to broadcasters for selecting the appropriate digital codec equipment suitable to their needs, such as MPEG-2 4:2:0, MPEG-2 4:2:2, DVCPRO 4:1:1 and 4:2:2, and other codecs. With regard to use of the Sony Betacam SX or the Panasonic DVCPRO, SBE even states that "compression is not so severe that several sequential compression/de-compression cycles cannot be tolerated." (SBE at 5).

An example of programming material undergoing three generation compression cycles while maintaining high video quality exists today with some sports programs. Sports program distributors typically backhaul "contribution" programming (4:2:0, 704x480I) from a satellite truck to their broadcast center at about 8 Mbps. Such signals are decompressed back to NTSC composite analog, switched, edited, graphics added, stored on nonlinear media, etc. This material is then broadcast to affiliates by recompressing and retransmitting over satellite at 8 Mbps. In some cases, affiliates include DBS operators, who decompress the "distribution" signal back to analog composite NTSC, then recompress again in MPEG-2 at 5-8 Mbps for retransmission to their customers in slightly reduced resolution.

4. Latency

The broadcasters express concern that unnecessarily long latency (potentially introduced by some digital video codecs) could cause problems for live interview programs and other real-time interactive events. (SBE at 6-7; ABC at 13) However, digital compression latency is not a real problem today and can be mitigated rather easily. Many digital video MPEG-2 codecs already commercially available can be flexibly configured to modify the Group of Pictures (GOP) structure in the compression algorithm to employ more I-frame coding. The MSS Coalition recognizes that using digital compression biased towards I-frame coding will increase the bit rates. However, these higher bit rates can still be transmitted within a 12 MHz RF channel plan using higher-order modulation schemes which are more bandwidth efficient (bits/hertz) than QPSK (i.e 8 phase PSK or 16 QAM). In so doing, the compression latency can be reduced to less than 150 milliseconds ("ms") at 8 Mbps output bit rate, as documented in published specifications of Tiernan's MPEG-2 codec. Other codecs, such as Leitch's MPEG-2 codec, which will be available in late 1997, are demonstrating latency of approximately 100 ms for their new codecs. These delay figures are an order of magnitude less than what the broadcasters had tested in 1995 and are substantially less than the 250 ms delay associated with just the propagation time over a satellite link for comparable live "real-time" applications.

SBE seems to indicate that having a combination of wired and RF cameras in live interview field production situations will cause disturbing delay mismatch problems between these two types of cameras if the RF cameras incorporate compression. (SBE at 6.) Since both the wired and RF cameras will undergo compression, there will be little, if any, noticeable delay mismatch between the two camera types, as both signals are transmitted to the receive site via the central production site (ENG truck).

5. Robustness

SBE appears to take issue with the MSS Coalition's statement that a digital TV signal can be far more robust than an analog TV signal (SBE at 6), but in fact their concerns are limited to so-called "non-engineered" paths, which are not defined by SBE but which we take to be paths that are lossy or partially obstructed or that involve reflections off of buildings.

SBE does not disagree with the MSS Coalition's main position that digital video signals can be far more robust than analog signals in the cases where forward error correction ("FEC") is employed (SBE at 6). However, it is precisely in degraded paths or in noisy environments that the MSS Coalition recommends using FEC in the digital transmission of the encoded video signals to ensure robustness as discussed throughout the White Paper. (MSS Coalition Petition, Exhibit A at 8-9.) Thus, FEC operates by transmitting redundant bits to compensate for bits that are either lost or errored in marginal signal paths.

It is reasonable to expect that a digital link will have a higher power margin, over a wider range of received C/No (or Eb/No levels) as compared to the FM link. Thus, it is likely that link budget analyses will show that QPSK provides 7 - 10 dB link performance improvement over analog FM.

This performance would indicate a significant expansion of operating range and link robustness. Typically, QPSK is at least 7 dB better, and 8-phase PSK 3 dB better, as compared to analog FM. COMSAT is quite willing to conduct "over-the-air" field tests with actual analog-FM ENG equipment versus digital compression/transmission equipment to validate that under realistic operating conditions the digital link will operate at more than twice the distance of the analog link with the same or better video quality performance.

6. Frequency Coordination

SBE (at 7) and BELO (at 2-3) state rather generically that the MSS Coalition's proposal would significantly hinder frequency coordination among [ENG] users. According to SBE, "a [flexible channel] plan would simply make agile spectrum sharing and real-time coordination impossible because the channels would no longer be interchangeable. Borrowing channels would become much more difficult, thus fostering an absolute requirement for more channels to handle the [requirements] resulting [in] less efficient use of available spectrum." (SBE at 7.)

SBE seems to imply that the MSS Coalition is proposing an infinite variability in the bandwidth occupancy used by compressed digital video signals. While this is theoretically possible with today's latest generation of codec equipment, that is not what the MSS Coalition proposed. We support the idea of having standardized channel sizes. Nevertheless, the flexibility of different transmission rates (bit rates + code rates) can be used to design a more flexible channelization plan incorporating more than one fixed bandwidth. The MSS Coalition proposed two different channel plans, and each plan gave the broadcasters the option to select two standardized channel bandwidth settings. In the White Paper (at 12-13), we presented one plan which divided the 85 MHz into seven 12 MHz channels, with the option for each of these channels to be sub-divided into two 6 MHz channels. When sub-divided into 6 MHz increments, a total of 14 channels would be possible. Our 5/10-channel plan offered five channels of 17 MHz, with the option of dividing each of these into two channels of 8.5 MHz each, for a total of 10 channels.

The 5/10-channel plan illustrates the benefits of a two-state variable bandwidth. Essentially, stations wishing to retain the ability to transmit ENG via FM (see below for discussion of portable ENG operations) could do so on a channel exactly matching the 17 MHz of existing ENG channels 3 through 7; whereas, a given TV station transmitting compressed digital TV would use the smaller, sub-divided bandwidth of 8.5 MHz. The MSS Coalition realizes that local ENG frequency coordinators would have to be notified as to which mode (FM or digital-TV) a given station was intending to transmit in and which channel size it will utilize, in order to coordinate the spectrum with other local TV stations. The MSS Coalition does not see a two-state channel bandwidth plan as being any more complex than the frequency coordination processes that broadcasters or frequency coordinators must contend with today. Broadcasters would actually have more flexibility under the MSS Coalition's proposals than they do under current modes of operation. For example, we note ABC's acknowledgment in its comments that "[b]roadcasters have, so far, been able to continue to operate with no additional channels, often by doubling up and re-using channels in inventive ways wherever possible." (ABC at 6; see also BELO at 3.)

ABC's statement reveals that local frequency coordinators for BAS/ENG can deal with sophisticated modes of operation, including a selection of different bandwidths. For example, when ENG operators use offset carrier center frequencies, they operate two TV carriers per ENG channel, using truncated or reduced deviation FM carriers within the one ENG channel and a narrower IF filter selection in the TV station ENG receiver. These circumstances show that ENG operators are fully capable of dealing with at least two different bandwidths per channel; i.e., standard and narrow bandwidths.

Clearly, the possibility of having a channelization plan that offers a capacity of 10-14 channels, rather than the current 7, should be of particular interest to the broadcasters in the top 25 markets where there is a need for additional channels to accommodate the additional networks, (e.g., CNN, ESPN, FOX, UPN, etc.). (ABC at 5-6).

7. Equipment Portability

ABC (at 11-13), and to a lesser extent SBE (at 6), and BELO (at 2), criticize the MSS Coalition for ignoring the broadcast industry's use of moving (portable) RF cameras. They claim the MSS Coalition erred in focusing its analysis on the "temporary fixed van" model of electronic news gathering. ABC (at 12) states that the portable transmitters in use today are useful because they operate from batteries, are extremely small in size and light weight, and have low power consumption, as compared to the bulkier digital codecs such as the DV2000 made by COMSAT-Wegener. In ABC's opinion, the lack of available digital equipment meeting these characteristics would preclude the networks from transmitting moving camera pictures of news and sports events.

First, portable use, while not insignificant, is certainly not the predominant type of BAS/ENG operation. A 1995 survey done by the broadcasters of all ENG usage shows that while the TV stations on average owned a total of 5.1 transmitters of all types (e.g. fixed, permanently installed, or portable) per station, only 1.5 transmitters per station, approximately, were of the portable type. Similarly, while TV stations maintained an average of 3.9 receivers in total per station, each station owned only 0.8 portable receivers on average. (MSTV Comments, May 5, 1995, Figures 1 and 2, at 3-4). These figures, from the broadcasters' own survey, hardly suggest that portable use is the predominant type of BAS/ENG operations.

Second, contrary to the broadcasters' assertions, the MSS Coalition's White Paper did not conclude that 100% of all BAS/ENG operations would have to be carried via a digital compression / transmission mode. MSS recognized that the broadcasters likely would need to operate with a mixture of analog and digital transmission techniques, simultaneously, for the foreseeable future. (MSS Coalition Petition, Exhibit A, at 12-13.) Thus, broadcasters should be able to select the channel configuration that best meets their transmission needs.

Third, the broadcasters' statistical data lists a category for "Tripod-to-Van" mode of operations. (MSTV Reply Comments, June 21, 1995, Exhibit B, "Estimate of Relocation and Retrofit Costs for the 2 GHz BAS to Accommodate MSS"). This may be interpreted as meaning that portable ENG (RF cameras) usually transmit not to the TV station receive site directly, but back to the

ENG van, where the signal is then relayed back to the station. While compression may not actually be feasible on the first relay, this last relay to the station could easily be digitally compressed at the ENG van prior to retransmission to the TV station.

Finally, in such situations, and because the battery-operated RF cameras transmit at very low RF powers (frequently omni-directional antennas are used), it is feasible to employ frequency re-use, given that the low power RF camera signal will not likely cause significant interference to the high power ENG van transmission (using the same or overlapping ENG channel) at the receive site.

Other alternative operations also are available. One is to use digital cameras with codec functionalities built in, such as the Panasonic DVCPRO and Sony SX. Another option is to mount the portable cameras and codec equipment on platforms such as motorcycles to cover moving sporting events such as marathons. Yet another, even simpler option is to use wired portable cameras rather than wireless RF portable cameras. This latter solution eliminates the need to have the codec equipment contained in the camera and transfers the digital compression function over to the ENG truck. Finally, not all portable camera situations even require "real-time" transmission. In these cases, the video can be recorded to tape and forwarded to the station from the ENG truck at a later time, consequently eliminating any RF transmission from the camera. ABC (at 6) admits to substantive advances in video technology, using the example of "camera systems have become miniaturized in size and weight". It is also reasonable to anticipate even further advancements in the miniaturization of camera systems such that the codec and modem functionalities could be combined with the camera itself, in future years.

AFFIDAVIT

We hereby certify that we are the technically qualified persons responsible for the preparation of the engineering information contained in the Exhibit A that we are familiar with the technical characteristics of the digital and radio communications systems described in the Exhibit A, that we have either prepared or reviewed the engineering information submitted in the Exhibit A, and that it is complete and accurate to the best of our knowledge and belief.

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Date: July 2, 1997

CERTIFICATE OF SERVICE

I, Kathryn M. Stasko, do hereby certify that the foregoing **REPLY OF THE MSS COALITION** has been furnished, via first class mail, on this 2nd day of July, to the following:

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